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Studies of Morphological Characteristics and Production of Seeds Weeds of Species of Family Brassicaceae (Cruciferous) in Setifian High Plateau, Algeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author MH designed the study, wrote the protocol and the first draft of the manuscript. Authors RL and MF managed the literature searches. Authors MH and RL wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The study of production and morphological characteristics of seeds allows identifying the different seeds mixed with cultivated plant; it also allows knowing the various species of weeds in fields. So such studies help to develop different strategies to control weeds.

Methodology: The work on the identification starts by collecting seeds from fields then study it thoroughly in the laboratory where researchers often observe it by naked eyes, in addition to the reliance on references and researches concerning describing seeds to make the study effective and successful it must be conducted carefully with continual vigilance because of the smallness of some seeds so we use magnifying glass, the optical microscope and pocket lamp to see the different external parts of seeds.

Results: Generally, members of the species Brassicaceae have small seeds with mostly less than 4 mm long. Seeds can have appendages or not. The seed shape among the investigated species

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showed wide range of variations. Most of the seeds vary from globose to oblong or oval. The largest seed size is 2.8-3.5 x 0.7-1.1 mm in oval and globose seeds. Seed surface may be smooth, glabrous, or rough that can be useful for identifying species. The seed colour varies from dark reddish, brown to golden red-brown, reddish-brown to dark brown, yellow dark to brown, yellow, shiny brown, Brown dark to black, range-rown, red-brown, grey, black. The production of seeds varies depending on the culture in which the weed grows. Seed production was determined for 10 weed species of Brassicaceae. Studies on seed production potential in *Capsella bursa-pastoris*, *Conringia orientalis*, *Diplotaxis eruroides* and *Diplotaxis virgata* showed that each plant produces an average of 2500±480, 7800±627, 2200±308 and 3600±48 seeds respectively. *Hirschfeldia incana* produces 14000±279 seeds /plant whereas *Neslia paniculata* produces 1540±526 seeds/Plant. One isolated *Sinapis arvensis* plant can produce over 1200±398 seeds. Thus *Rapistrum rugosum* produced 280±17 seeds per plant.

Conclusion: Seeds morphological description is related to external description of seed, weeds seeds show very big differences as well as seeds of the same species which also can show many morphological differences. The ability to produce seeds with different degrees of dormancy is, most probably, a mechanism by which species of Brassicaceae as other weed species adapts to new environmental situations and ensures its survival by facilitating the dispersal of its seeds in time and space.

Keywords: Brassicaceae; Morphological characteristics; seeds; weeds; seeds production.

1. INTRODUCTION

The predominance of a weed species is the result of high capacity for reproduction and efficient mechanism for dispersal, survival, adaptation and competition [1]. Accurate weed identification is the first step in a successful weed management program. Weed species respond differently to different management strategies [2]. Weed seeds are difficult to manage because they are small, and produce a large amount of seeds [3]. Weeds are one of the most significant limiting factors in agricultural production. Weeds compete strongly with crops for light, water and nutrients. This brings about severe interference with normal crop growth, causing high crop losses and reducing the quality of produce. Most annual weeds produce a prolific number of seeds each year. Production of abundant small seeds is a common adaptation that ensures a high probability of dispersal and reinfestation [4]. The presence of a weed is both linked to an ecological environment (soil, climate) and agronomic practices [5], and edaphic conditions (pH, texture) [6,3] and number of seeds produced [7]. This number is highly variable between species and within a same species [8]. This production of seeds varies depending on the culture in which the weed grows [9].

The Brassicaceae, which currently includes 3709 species and 338 genera [10], is one of the ten most economically important plant families [11]. In Brassicaceae, much attention was paid to the

general anatomy of the seed coat and its taxonomic use particularly in species of economic value [12]. Discrimination between Brassicaceae seeds is very difficult with the naked eye or lens. On the other hand, Fayed and El-Neggar [13] stated that the cruciferae is classified into 13 tribes, Arabideae, Hesperideae, Lepidieae, Matthioleae Sisymbrieae, Alysseae, Brassiceae, Chamireae, Schizopetaleae, Stenopetaleae, Helphiteae, Cremolobeae, Drabeae, Euclidieae, Lunarieae, and Streptantheae only two tribes, the Brassiceae and Lepideae can be regarded as natural. It is the reason why micromorphological structures have been observed on the surface of the seeds [14]. Most systematists agree that studies of morphological characteristics of seeds is very significant for the classification of Angiosperm taxa.

Seed is a vital genetic source and dispersal unit between successive generation of plants, and it possesses very reliable and constant characters in various groups of seed plants [15]. A good identification weeds allows to choose the appropriate herbicide, and the identification of this weed will be easy if its morphological characteristics are well determined [16,17,4]. weeds cause considerable losses over the world as well as the region of study where Fenni [5] evaluated these loss by rates vary between not controlled .Weeds become more dangerous if nor controlled or treated by herbicides, in addition techniques used to till the soil are insufficient or not applied perfectly, the spread

and the propagation of weeds will increase [18,19]. The study of weeds in every respect is very important in addition to study of seeds which play big role in propagating weeds [20,21]. Menalled [22] confirmed that gathering and study seeds are very important in malherbology because this latter can help us to identify seeds and know it if it mixed with wheat seeds.

The following research deals with the production and the identification of the most morphological characteristics which help to describe seeds in order to know them, so the identification of the species can strength compete with the cultivated plant. The main purpose is attempting to find the effective methods in control to increase production and to try to attain sufficiency.

2. MATERIALS AND METHODS

2.1 Plant Material

In this study seeds of 10 different species of Brassicaceae were collected from various crop fields located in the region of Setifian high plateau which situated in the north east of Algeria between the two longitude 5° and 6° and between the two latitudes 35°40 and 36°35. After maturation of the seed we collect as many as possible, we put the seed in paper bags to keep it dry and to avoid humidity and climatic factors which lead to germinating these seeds; they were kept in normal condition of laboratory.

2.2 Seeds Production

Five mature plants per weed species were randomly collected in an area of about 50 x 50 m. Each plant was placed in a paper bag. The plants were subsequently sanded and the mature seed are cleaned manually and counted.

2.3 Morphological Characteristics

Seeds morphological discrimination is related to external description of all the characteristics of seed. The study requires taking 05 seeds randomly of each species [4]. Apparent substantial information helps researchers to identify or describe seeds. the work on the identification starts by collecting seeds from fields then study it thoroughly in the laboratory where researchers often observe it by naked eyes, in addition to the reliance on references and researches concerning describing seeds to make the study effective and successful it must be conducted carefully with continual vigilance

because of the smallness of some seeds so we use magnifying glass, the optical microscope and pocket lamp to see the different external parts of seeds [23,24].

Surface characteristics of the seeds are very important in Brassicaceae identification and require a microscope with a magnification of at least 40 X. However, it may be surprisingly helpful to view seeds with the naked eye, and then again with low magnification (10 – 20 X), before moving to the higher power. Because over-all size, shape, color, and texture are visible at low magnification, it is usually possible to narrow down the choices during this step. Also, the analyst may find contaminants more easily at low magnification than at a high power where the over-all characteristics may be lost.

The morphological characteristics in which the study was based on were used by different researchers for example the characteristics like size, weight ,color and shape were used as suggested by various workers such as [25,26,27,16]. As well as other some researchers who bear on other characteristics such as solidity, brightness, surface [28], appendages [29]. Generally the characteristics were used in this study are the result of the most important characteristics which were used in the different researches of seeds identification.

3. RESULTS AND DISCUSSION

3.1 Morphological Characteristics

In order to identify the different morphological characteristics of seeds species of Brassicaceae, we found that the single character is not enough to distinguish the species because the seeds of more than one species possess same mean value however their standard deviations vary. But the consideration of these characteristics collectively was found unique in this study. The identifying characters described and used in this publication are found only on the external surface of the seeds. Their usefulness for identification varies. Characters of major importance are color, size and shape of the seed [4,24]. Other characters used in conjunction with these features have limited use. So these characteristics may serve as a convenient method for identification and classification of weeds on the basis of their seed bank available in the soil [30]. Seeds of weed species included in this study are represented in photos (Photo 1 to Photo10).

Assogbadjo et al. [8] considered that seeds are the main cause of big differences can be shown by species, races, and families because all differences are in the seed which gives birth to the new plant. Each weeds species shows morphological characteristics different from the plant or other species, these morphological characteristics are not restricted to the external

form of the plant only but it can be on level of different other parts of plant like fruit and seed [31].

In Brassicaceae, morphological characters of seeds have been studied by many people such as Kacem et al. [12], Warwick et al. [10], and Bernard [14]. Generally, members of the species



**Photo 1. Seeds of
*Capsella bursa-
pastoris* (L.) Medick**



**Photo 2. Seeds of
Conringia orientalis
(L.) Dumort**



**Photo 3. Seeds of
Diplotaxis eruroides
(L.) DC**



**Photo 4. Seeds of
Diplotaxis virgata
DC**



**Photo 5. Seeds of
Eruca vesicaria (L.)
Cav**



**Photo 6. Seeds of
Hirschfeldia incana
(L.) Lagr.-Foss**



**Photo 7. Seeds of
Neslia paniculata
(L.) Desv**



**Photo 8. Seeds of
Rapistrum rugosum
(L.) All**



**Photo 9. Seeds of
Sinapis alba L.**



**Photo 10. Seeds of
Sinapis arvensis L.**

Brassicaceae have small seeds with mostly less than 4 mm long [29] (Table1). Seeds can have appendages or not. The seed shape among the investigated species showed wide range of variations. Most of the seeds vary from globose to oblong or oval. However, they are kidney in *Diplotaxis eruroides* and *Hirschfeldia incana*. The seed shape as observed in the present study seems to be diagnostic at the generic level.

Seed size varies greatly. The largest seed size is 2.8-3.5 x 0.7-1.1 mm in oval and globose seeds of *Neslia paniculata* and *Rapistrum rugosum*, medium (*Sinapis alba*, *Sinapis arvensis*) or small sizes in the rest studied species (Table 1). The seed size as a variable criterion is considered diagnostic for some extent. This is in accordance with the work of Aniszewski et al. [32]. Seed surface may be smooth, glabrous, or rough that can be useful for identifying species [33], the seed surface can serve as good diagnostic parameters at the generic and specific level in the studied Brassicaceae. This is in accordance with the work of Rich [11], Fayed and El-Naggar [13] and Abdel Khalik and Maesen [34].

The seed colour varies from dark reddish,brown to golden red-brown, reddish-brown to dark brown,yellow dark to brown,yellow,shiny brown,Brown dark to black,range-rown, red-brown, grey, black (Table 1). The seed color is diagnostic at the generic and specific level for some extent. The data of seed color is compatible with that mentioned before by Mehmet [35] and Rich [11].

Table 2 showed that seeds of Brassicaceae are ridged in the most of species such as *Neslia paniculata*, *Rapistrum rugosum*, *Sinapis alba*, *Sinapis arvensis*. Seeds vary between bright in *Capsella bursa-pastoris*, *Diplotaxis eruroides*, *Diplotaxis virgata*, *Hirschfeldia incana*, *Neslia paniculata*, *Rapistrum rugosum*, *Sinapis alba* and *Sinapis arvensis*, and Pale in *Coringia orientalis*, *Eruca vesicaria*, *Neslia paniculata* *Rapistrum rugosum*. Seeds can have a short beak in *Neslia paniculata* and *Rapistrum rugosum*. Weights per 100 seeds (mg) vary, the biggest seed weight is 0.60-0.85 mg in *Rapistrum rugosum* and the smallness one is *Hirschfeldia incana*.

Table 1. Morphological characteristics of species seeds (Shape, Color, Size, Surface)

Species	Morphological characteristics			
	Shape	Color	Size	Surface
<i>Capsella bursa-pastoris</i> (L.) Medick (Shepherd's-purse)	Oblong- ellipsoid	Dark reddish-brown to golden red-brown	0.9 - 1.2 mm 0.4 - 0.6 mm	Smooth
<i>Conringia orientalis</i> (L.) Dumort. (Hare's-ear mustard)	Oval – oblong	reddish-brown to dark brown	1.5. -1.8 mm 0.7-1.2 mm	Glabrous
<i>Diplotaxis eruroides</i> (L.)DC (White wall-rocket)	kidney	Yellow dark to brown	0.4-1.0 mm 0.4-0.6 mm	Glabrous- smooth
<i>Diplotaxis virgata</i> DC. (Wall-rocket)	Oval	Yellow	0.6 – 0.9 mm 0.3 - 0.5 mm	Smooth
<i>Eruca vesicaria</i> (L.)Cav (Rucola)	Oblong	Yellow dark to brown	1.0-1.7 mm 0.5-0.8 mm	Smooth
<i>Hirschfeldia incana</i> (L.) Lagrèze (Hoary mustard)	kidney	shiny brown	0.8-1.0 mm 0.5-0.7 mm	Glabrous- smooth
<i>Neslia paniculata</i> (L.) Desv. (Ball mustard)	Oval	yellow to yellowish- brown	2.9-3.4 mm 0.7-1.1 mm	Rough
<i>Rapistrum rugosum</i> (L.)All. (Bastard cabbage)	Globose	yellow to yellowish- brown	2.8-3.5 mm	Rough
<i>Sinapis alba</i> L. (Yellow mustard)	Globose	Brown dark to black	2.0-2.8 mm	Glabrous
<i>Sinapis arvensis</i> L. (wild mustard, charlock)	Globose	Red-brown,black	1.9-2.9 mm	Smooth

In Brassicaceae, morphological characters of seeds are useful to determine the taxonomic boundaries among taxa, especially genera and species, and to realize their relationships (Koul [36], Fayed and El-Naggar [13]).

3.2 Seeds Production

Seeds production that is to say the number of seeds produced per plant weed. Knowledge of this number is essential firstly in understanding the dynamics of weed populations and also in selecting long weed control strategies term [13]. The production of seeds varies depending on the culture in which the weed grows. Number of seeds produced per plant is represented in Table 3.

Seeds production was determined for 10 weed species of Brassicaceae. Tanji, [21] stated that one species of Brassicaceae weed is capable of producing 20000 seed per plant. Studies on seed production potential in *Capsella bursa-pastoris*, *Conringia orientalis*, *Diploaxis eruroides* and *Diploaxis virgata* showed that each plant produces an average of 2500 ± 480 , 7800 ± 627 , 2200 ± 308 and 3600 ± 48 seeds respectively, [18].

Hirschfeldia incana produces 14000 ± 279 seeds /plant whereas *Neslia paniculata* produces 1540 ± 526 seeds/Plant [3]. One isolated *Sinapis arvensis* plant can produce over 1200 ± 398 seeds. Thus *Rapistrum rugosum* produced 280 ± 17 seeds per plant [21].

Most weed species are prolific seed manufacturers, in some cases producing a more than 10000 seeds/plant (see Table 3 for more information). These seeds produced are eventually deposited either onto the soil adjacent to the parent plant or transported to another area where they wait for the adequate conditions to germinate and grow [18]. Annual weeds depend on seed production as the sole means of propagation and survival. Production of abundant small seeds is a common adaptation that ensures a high probability of dispersal and re-infestation [37]. Due to high seed production potential combined with dormancy, seed longevity possesses higher advantage as there is a chance of at least for some of them to germinate and grow into new plant, a single plant of an annual weed can produce enough seeds in one season to cover an area of one acre [38].

Table 2. Morphological characteristics of species seeds (Solidity, Brightness, Appendages, Weight per 100 seeds)

Species	Morphological characteristics			
	Solidity	Brightness	Appendages	Weight per 100 seeds (mg)
<i>Capsella bursa-pastoris</i> (L.) Medick. (Shepherd's-purse)	Fragile	Bright	None	0.03-0.08
<i>Coringia orientalis</i> (L.) Dumort. (Hare's-ear mustard)	Solid	Pale	None	0.07-0.10
<i>Diploaxis eruroides</i> (L.) DC (White wall-rocket)	Fragile	Bright	None	0.04-0.09
<i>Diploaxis virgata</i> DC. (Wall-rocket)	Fragile	Bright	None	0.03-0.07
<i>Eruca vesicaria</i> (L.) Cav (Rucola)	Solid	Pale	None	0.07-0.11
<i>Hirshfeldia incana</i> (L.) Lagrése (Hoary mustard)	Fragile	Bright	None	0.03-0.07
<i>Neslia paniculata</i> (L.) Desv. (Ball mustard)	Solid	Pale	Short beak	0.55-0.70
<i>Rapistrum rugosum</i> (L.) All. (Bastard cabbage)	Ridged	Pale	Short beak	0.60-0.85
<i>Sinapis alba</i> L. (Yellow mustard)	Ridged	Bright	None	0.40-0.70
<i>Sinapis arvensis</i> L. (wild mustard, charlock)	Ridged	Bright	None	0.50-0.75

Table 3. Seeds production capability (\pm SD) of Brassicaceae weed species

Weed species	Number of seeds produced per plant	Weed species	Number of seeds produced per plant
<i>Capsella bursa-pastoris</i> (L.) Medick. (Shepherd's-purse)	2500 \pm 480	<i>Hirshfeldia incana</i> (L.) Lagrèse (Hoary mustard)	14000 \pm 279
<i>Conringia orientalis</i> (L.) Dumort. (Hare's-ear mustard)	7800 \pm 627	<i>Neslia paniculata</i> (L.) Desv. (Ball mustard)	1540 \pm 526
<i>Diplotaxis eruroides</i> (L.) DC (White wall-rocket)	2200 \pm 308	<i>Rapistrum rugosum</i> L.) All. (Bastard cabbage)	280 \pm 17
<i>Diplotaxis virgata</i> DC. (Wall-rocket)	3600 \pm 48	<i>Sinapis alba</i> L. (Yellow mustard)	980 \pm 280
<i>Eruca vesicaria</i> (L.) Cav (Rucola)	340 \pm 17	<i>Sinapis arvensis</i> L. (wild mustard, charlock)	1200 \pm 398

(\pm SD): Standard deviation

4. CONCLUSION

Seeds morphological description is related to external description of seed, weeds seeds show very big differences as well as seeds of the same species which also can show many morphological differences because of many factors, especially, the degree of maturity. Climatic changes from one year to another, some botanical diseases and environmental differences and many other factors affect change difference of morphological characteristics (form, color, size). The obtained results allowed identifying the most spread species of seeds in the region of study in addition to the characteristics using in the study of the morphology of the most identifications of seeds.

The ability to produce seeds with different degrees of dormancy is, most probably, a mechanism by which species of Brassicaceae as other weed species adapts to new environmental situations and ensures its survival by facilitating the dispersal of its seeds in time and space. This study may be useful for preparing model for predicting timing and weed seedling emergence before and during growing season to for effective control of weed with limited use of herbicides.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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